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INFO-0132

# AN EVALUATION OF THE URANIUM MINE RADIATION SAFETY COURSE

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A report prepared for the
Atomic Energy Control Board
Ottawa, Canada

**REPORT**

July 26, 1984

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## ABSTRACT

The report evaluates the Uranium Mine Radiation Safety Course focussing on the following areas: effectiveness of the course; course content; instructional quality; course administration. It notes strengths and weaknesses in these areas and offers preliminary recommendations for future action.

## RÉSUMÉ

Le rapport évalue le cours sur la radioprotection dans les mines d'uranium en fonction des aspects suivants: l'efficacité du cours; son contenu; la qualité de l'enseignement; l'administration du cours. Il fait état des points forts et des faiblesses dans ces domaines et formule des recommandations préliminaires en vue de plans d'action futurs.



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## PREFACE

The terms of reference for this report were as follows:

To evaluate the Uranium Mine Radiation Safety Course focussing on the following areas:

(a) Effectiveness of the course - are the course objectives achieved by the students.

(b) Course Content - is the content appropriate for the target group.

(c) Instructional Quality - are the techniques used by the instructors effective (including presentation style, course notes, learning aids)

(d) Course Administration - is the course being administered effectively (consider course schedule - facilities and other administrative arrangements).

In order to answer these questions the following research was undertaken.

(1) The following literature was reviewed: Proposed Regulations Respecting Uranium Mines (Consultative Document C-59); Proposed Regulatory Guide (Consultative Document C-78); Participant Manual for the Uranium Mine Radiation Safety Course.

(2) The Uranium Mine Radiation Safety Course in Saskatoon (May 14-18, 1984) was observed.

(3) Discussions were engaged with appropriate Atomic Energy Control Board (A.E.C.B.) personnel in order to obtain relevant information concerning the course and its path of development since 1976.

(4) Discussions were engaged with course participants.

This research coupled with our own in-house knowledge and expertise forms the main body of the report. The principal benchmarks against which the Uranium Mine Radiation Safety Course was evaluated are detailed in Appendix B. A summary of our findings and recommendations follows.

## SUMMARY OF FINDINGS

### Course Effectiveness

The Uranium Mine Radiation Safety Course (U.M.R.S.C.) achieves its principal aim which is to provide participants with a basic understanding of radiobiological hazards to workers and the environment. (see Chapter A., 2.1)

The U.M.R.S.C. is less effective in achieving its second major aim which is to provide participants with a practical approach to deal with these hazards. (see Chapter A., 2.2)

Stated course objectives are unrealistic and are not in accord with the Atomic Energy Control Board's present or proposed philosophy for basic radiation safety training. (see Chapter A., 1.1)

### Course Content

Course content is highly repetitive which increases the time and cost of training. (see Chapter B., 2.2.2; 3.; 5.2)

Portions of this content is highly technical and abstract and more applicable to higher levels of training than a basic course in radiation safety which places no restrictions on participants entering behaviour. (see Chapter B., 1.; 2.2; 5.2; 5.3)

Course content on the whole fails to raise and sustain a practical image from the work environment.

Instructional Quality

The success of the present course is attributable to a clearly projected concern on the part of ALL instructors and administrative personnel with the health and safety of workers in the Uranium mining environment. This provides the foundation for fostering positive attitudes in the operational environment.

This positive attitude is supplemented by a number of skilled lecturers who effectively communicate key knowledge components. (see Chapter C., 1.; 1.1)

Course lecturers often appear unaware of what has preceded or will follow their particular lecture. This compounds the problem of repetitive content and adversely affects the cummulative effect and unity of the course.

The mechanics of individual presentations - review of objectives and placing content in perspective of overall aims and what has preceded and will follow - is highly variable.

Visual aids are for the most one-dimensional (ie. overhead transparencies) and often violate the well documented principles for visual aids. (see Chapter C., 2.)

Course Administration

The U.M.R.S.C., under the direction of the Canadian Institute for Radiation Safety, is competently administered.

## RECOMMENDATIONS

The presently stated objectives should serve as guidelines for content decisions and sequencing but should not be viewed as objectives to be achieved. (see Chapter A., 1.1)

The present participant questionnaire should be replaced. (see Chapter A., 3.; APPENDIX A)

All course instructors should use a common presentation structure. (see Appendix B., B5)

Visuals and case studies should be developed to provide a sustained practical theme for the flow of teaching points. (see Chapter B., 2.2.1; 2.2.2; 4.; 5.2; 7.; Chapter C., 2.)

Abstract concepts - particularly in the area of Radiation Fundamentals and Units and Ventilation Concepts and Design - should be reworked and expressed in terms and examples which are consistent with the entering behaviours of course participants. (see Chapter B., 1; 2.2; 2.2.1; 2.2.3; 5.2; APPENDIX B)

The historical perspective now included in Radiation Fundamentals should be deleted from course content. (see Chapter B., 2.1)

Lecture 4 (Radiobiological Hazards in Mining) and Lecture 10 (Regulatory Basis of Dose Limits and Radon and Thoron Daughter Exposure Limits) should be consolidated and resequenced as content under Radiation Fundamentals and Units. (see Chapter B., 2.2.2)

Only S.I. units of measurement should be used. (see Chapter B., 2.2.3)

The content presently included in Lecture 5 (Radiation Hazards in Mines and Mills) should be distributed throughout previous and ensuing lectures. (see Chapter B., 3.)

Lecture 16 (Sources and Control of Dust in Mines and Milling) should be resequenced to follow the revised content of Radiation Fundamentals and Units. (see Chapter B., 5.1)

Lecture 8 (Control of Internal Exposure to Short-Lived Radionuclides in Underground and Open Pit Mines) and Lecture 14 (Ventilation in Uranium Mines: Design and Maintenance) should be consolidated. (see Chapter B., 5.2)

Lecture 9 (Regulatory Process) should initiate the course. (see Chapter B., 6.2)

Lecture 15 (Regulatory Philosophy for Uranium Mining) should conclude the formal lecture session. (see Chapter B., 6.3)

Lab Sessions should be reduced to one half-day each. (see Chapter B., 7.)

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## A. EFFECTIVENESS OF THE COURSE

### 1. Validity of Objectives

An evaluation as to whether or not the U.M.R.S.C. achieves its objectives begs the true question - are the objectives valid in the first place? As presently stated the objectives of the U.M.R.S.C. are as follows.

By the end of the course, participants will be able to:

(a) Define basic radiation concepts, terms and units;
(b) Describe the radiation hazards to man associated with uranium ore, radon and thoron gas and their daughter products, and uranium ore dust;
(c) Discuss the biological effects of radiation exposures;
(d) Describe the techniques used to manage mine and mill wastes;
(e) Monitor, prevent, and control radiation problems in mines and mills;
(f) Outline objectives of and techniques used in dosimetry programmes and record keeping systems, including the National Dose Registry;
(g) Describe the regulatory philosophy and process for uranium mining and milling in Canada;
(h) Discuss the basis for regulatory dose limits and radon and thoron daughter exposure limits;
(i) Discuss the obligations of workers, union and management under AECB licenses and regulations;
(j) Contribute to the education of co-workers in all aspects of radiation safety.

## 1.1 Objectives Unrealistic

On initial inspection these objectives seem reasonable. They are consistent with the stated aims of the course and they are couched for the most part in measurable terms. In reality however, they are neither measured, nor, we contend, in large part achieved. If it is truly an objective of the course to have participants define basic radiation concepts, describe radiation hazards, outline objectives of dosimetry programs, etc., then their ability must be measured with written criterion testing. If it is truly an objective of the course to have participants be able to monitor, prevent and control radiation problems then their ability must be measured by applied criterion testing. Furthermore, if these objectives are to be not merely tested, but also achieved, then radical revision with respect to the course content and design would be required.

Our investigations lead us to conclude that the stated objectives are unrealistic and not in keeping with the A.C.E.B.'s philosophy with respect to basic training safety for uranium mine workers. This philosophy is adequately defined by the present course aim which states that "the aim of the course is to provide participants with a basic understanding of radiobiological hazards to workers and to the environment, and with a practical approach to deal with these hazards." These aims provide a perfectly sound foundation for a basic course in radiation safety.

The presently stated objectives should serve as guidelines for content decision and not as objectives to be achieved. If elaboration on aims is deemed necessary the nine (9) points noted in Schedule III, Part I of the Proposed Regulations Respecting Uranium Mining are perfectly adequate. A miner who learns nothing more than the importance of dosimetry in protecting his health and/or changes his behaviour by consistently applying standard operating procedures in the extension and operation of ventilation tubing could not be deemed to have achieved course objectives but would certainly have achieved the aims of the course.

## 2. Achievement of Aims

### 2.1 Increase in Awareness and Knowledge

Measured from an achievement of aim perspective there is much to commend the U.M.R.S.C. There is no question that participants knowledge and awareness of radiobiological hazards is substantially increased. This achievement is attributable to two factors.

(1) The clearly projected concern on the part of all lecturers and administrative personnel with the health and safety of individuals who work in the uranium mining industry and with the importance of adopting proper work habits in light of radiobioligical hazards.

(2) The contribution of some truly skilled lecturers who effectively communicate these principles. While we commend their achievement we must also note that these same results could be obtained in a more effective manner and in less time. These changes require revision in content, and instructional quality.

### 2.2 A Practical Approach

In addition to increasing knowledge and awareness the U.M.R.S.C. also aims to provide participants with a practical approach to dealing with radiobiological hazards. In essence this means to 'show by example' so that participants can do likewise when they return to the work environment. We find that this aim is not nearly as well addressed as the knowledge component of the course. There is lip service paid to this in lab sessions and a ventilation workshop but a practical image for the application of course knowledge is not raised and sustained in the present course. Chapters B and C offer some suggestions on how this practical approach can be strengthened within the constraints imposed by a classroom training environment.

### 3. Course Participant Questionnaire

Course participant questionnaires are an effective means of evaluating course effectiveness. Properly designed they can give valid feedback on the achievement of objectives without invoking formal written or applied testing procedures. While not to disparage feedback in any form from participants we do not regard the present questionnaire to be an effective tool for evaluation purposes.

Consisting essentially of open-ended questions, it places far too much demand on course participants. Those questionnaires which we have reviewed from the Saskatoon course (May 14-18) were poorly completed and tend to support this claim. Effective evaluation forms are those which predominantly require scale rankings as opposed to prose responses.

An example of an effective generic questionnaire which participants readily complete, and which very quickly yields statistically significant feedback on course effectiveness is enclosed for review. (see Appendix A)

## B. COURSE CONTENT

We find redundancy and abstract presentation of content to be particularly troubling in the U.M.R.S.C. This chapter notes repetition in lecture content and offers some preliminary suggestions as to how these problems might be overcome. It also makes suggestions as to how a practical approach to the application of content can be developed and sustained throughout the course.

### 1. Entering Behaviours

The base entering behaviour of course participants is always the limiting factor when making decisions on course content. Given that the U.M.R.S.C. places NO restrictions on participant

educational level or work experience, it follows that content decisions and the presentation of this content must be weighed against two factors.

(1) The material is likely to be new to the learner and designers and instructors must think constantly in terms of the beginner.

(2) In planning examples for comparison and illustration, designers and instructors must keep them simple, express them clearly and concisely, and as much as possible place them within the context of the workers' environment. This means that abstract concepts must be reworked and expressed in terms and examples which course participants can understand. Training courses which do not include either written or applied criterion testing are particularly susceptible to perpetuating this problem since participants - as so aptly noted in the lecture on Worker Education - are not about to admit incomprehension. (see also, Appendix B)

2. Radiation Fundamentals and Units (Lectures I, II, II)

This series of lectures is pivotal to the achievement of course objectives. They must clearly and firmly establish the following images and concepts.

(a) The concept of energy release from radioactive substances in Uranium Mine Workplaces.
(b) The concept of tissue absorption of this energy by Uranium Mine workers.
(c) The ionizing effect of this energy absorption.
(d) The inability of the human senses to detect this energy and the concomitant need to follow standard operating procedures in the workplace.

Measured against these objectives we find the following deficiencies in the presently constituted content for Radiation Fundamentals and Units.

2.1 Historical Perspective

Bearing in mind that the overall aim of the U.M.R.S.C. is to provide participants with an understanding of the need to follow proper work procedures in the workplace, we contend that an historical perspective on how we arrived at our present state of knowledge with respect to the physics of these hazards is irrelevant and only serves to deflect attention away from, and delay the introduction of, relevant teaching points.

We have no quarrel with the inclusion of this historical perspective - in prose form - as part of the background notes for course participants but they should be viewed solely as nice-to-know background and be pursued on an individual basis.

2.2 Content Too Abstract for Base Population

If the course is truly to begin at the beginning it must begin with a concise explanation of present knowledge respecting the physical properties of radioactive substances and how they pose a hazard in the workplace. As presently constituted we find that course content for fundamentals is neither appropriate for the base entering behaviours of course participants nor is it consistent with the course aims and objectives.

Dwelling inordinately on atomic theory and couching the major portion of teaching points and examples in abstract mathematical terms these lectures serve to obscure rather than clarify the principles of particle and wavelike ionizing radiation.

This critical evaluation is based on our belief that the principles of ionization can be - and given the base entering behaviour of participants should be - communicated in a

work-related, far less abstract manner. Two images raised in the course of the workshop lead us to this conclusion. The first is the image of 'happy and unhappy' atoms and the second is the image of 'tissue absorption of radiated energy'.

### 2.2.1 Happy and Unhappy Atoms

This vivid and compelling image was raised by the lecturer on Radiation Fundamentals. It offers a promising vehicle for the discussion of particle and ray radiation which emanates from Uranium ore, its products and waste products.

This discussion could be built around a limited number of visuals drawn from the actual working environment: a working face (underground and open pit); development drifts; ore belts; leach tail areas; etc. These visuals would act as background for a series of overlays illustrating the abstract principles inherent in:

- the atomic structure of stable and unstable atoms;
- the radiant energy release of unstable atoms;
- the decay series for U238

The methodology of instruction here could be instructor-led with overhead transparencies and or slides. Alternatively this presentation could be presented in a slide-tape, video or film format followed by a question and answer session. Regardless of the medium the result is a practical and significantly shorter method of cementing the image of energy release in Uranium Mine workplaces.

### 2.2.2 Tissue Absorption of Radiated Energy

The physic principles are only the means to the true end which is to foster an awareness of hazards in the workplace and the motivation to follow standard operating procedures. This awareness and motivation is in turn founded on a solid understanding of energy absorption and its potential for

biological harm. Any discussion of radiation units, and how these units are expressed in dose and exposure limits must be preceded by this understanding. Unfortunately, an effective treatment of energy absorption does not ensue until the last morning lecture of the second day of the course. This lecture, Lecture 10, entitled Regulatory Basis of Dose Limits and Radon and Thoron Daughter Exposure Limits is in large part a repetition of Lecture 3 (Radiation Units) and Lecture 4 (Biological Effects of Radiation) from day one of the course.

Consolidating the content presently contained in Lecture 4 and Lecture 10 and resequencing this content to follow immediately upon the physics of radiated energy from Uranium ore, would, we contend, result in more effective training.

Introducing the concept of residual cell damage associated with ionizing radiation and placing the risk associated with this absorption in an historical perspective leads logically to a discussion of the units and terms used to measure and express this absorption; how dose and exposure limits have evolved over time due to an accummulation of epidemiological data; and ultimately to a discussion of the basis for the currently proposed limits and how they differ from the presently operating limits.

Once again this content must be presented within the context of the workers' environment. The visuals which provide a framework for the physics concept could now be replaced with visuals showing workers themselves in this environment. These in turn provide a framework around which to discuss ionization, as well as providing a background for laboratory case studies which could provide a practical conclusion to the subsequent record keeping of worker exposure on a daily, weekly and monthly basis.

### 2.2.3 System of Measurement

A sound understanding of units and the unit measurement of workers' exposure to radioactive energy is also hampered by the

introduction of both the old and new systems of measurement. This approach leads to confusion between Rems and Sieverts, and Rads and Grays; which in turn leads to confusion with respect to the expressions of this energy absorption in dose and exposure terms. If exposure limits and the expression of these limits in unit terms are to be meaningful to course participants the course content must avoid this duplicity by introducing only S.I. units. Should this be determined to pose a problem for participants due to previous training then a conversion sheet could be provided.

3. Radiation Hazards in Mines and Mills

This lecture proposes to discuss the types of radiation, sources of exposure in uranium mines and mills, the units used to describe them, and the typical levels in Canadian uranium mines and mills. Apart from detailing typical levels encountered in specific mining environments this content is a repetition of previous content which in turn is repeated again in ensuing lectures. Repetition is a valid educational technique but should not be practiced to the point of redundancy. The content from this lecture - particularly that portion which documents specific environments in particular mines - should be distributed throughout previous and ensuing lectures.

4. Personal Dosimetry in the Uranium Mining Industry

This lecture is a necessary prerequisite to the radiation lab sessions just as the lectures on ventilation concepts and design are necessary prerequisites to the dust lab session. The content for this lecture is sound but is once again hampered by the lack of practical visuals. This lecture, as well as lectures 11 (Design and Operation of Uranium Mills and Personal Hygiene) and 12 (Uranium Tailings Management) could be effectively communicated by means of slide-tape or video formats.

## 5. Ventilation Concepts and Design

Given the critical importance of ventilation in controlling internal exposure to radiation we would contend that a formal treatment of this subject should precede traditional and personal dosimetry monitoring techniques. This could be achieved by resequencing Lecture 16 (Sources and Control of Dust in Mines and Milling) to replace Lecture 6 and consolidating the content presently contained in Lectures 8 (Control of Internal Exposure to Short-Lived Radionuclides in Underground and Open Pit Mines) and 14 (Ventilation in Uranium Mines: Design and Maintenance) into one Lecture.

### 5.1 Lecture 16 (Sources and Control of Dust in Mines and Milling)

This is an effective generic introduction to the characteristics of and health hazards posed by dust in mining and milling operations. It also provides, through practical analogous examples, a review of dust control techniques and the principles of ventilation. Supplemented by slides, to provide visual relief, this lecture could provide a sound foundation for a more detailed treatment of the control of radon daughters in mine air.

### 5.2 Consolidating Lecture 8 (Control of Internal Exposure to Short-Lived Radionuclides in Underground and Open Pit Mines) and Lecture 14 (Ventilation in Uranium Mines: Design and Maintenance).

Determining mine air resistance curves, the horse-power requirements of fans, stall points of fans, etc. is a higher order of training which may be a function of the job-related training program but is more likely to reside in formal educational institutions (mine-training institutes, institutes of technology, and universities). The introduction of this content is neither consistent with the aims and objectives of a basic course in radiation safety nor does it acknowledge the base entering behaviours of course participants.

If this technical content is eliminated from Lecture 14, what is left - with some minor variations - is essentially a repetition of the content in Lecture 8. The content of these lectures (ie. 8 and 14) should be consolidated and resequenced to follow the present lecture 16 (Sources and Control of Dust in Mines and Milling). This revised lecture, perhaps more than any other, demands graphic slide presentations drawn from the working environment to illustrate teaching points. If the lecture is to communicate practical solutions to radon daughter control difficulties then these solutions must be communicated in a practical realistic manner.

5.3 Ventilation Workshop

In line with our comments respecting entering behaviours and the objectives of a basic course in radiation safety we find that this workshop should be eliminated.

6. Regulatory Process and Philosophy

Regulatory process and philosphy is presently dealt with in three lectures: Regulatory Basis of Dose Limits and Radon and Thoron Daughter Exposure Limits; The Regulatory Process; Regulatory Philosophy for Uranium Mining. Our findings on the Regulatory Basis of Dose Limits and Radon and Thoron Daughter Limits are presented above. (see 2.2.2)

6.2 Regulatory Process (Lecture 9)

This lecture should initiate the course. It provides a concise overview of the history and background of the uranium mining industry; firmly establishes the unique nature of this industry; and introduces the regulatory goals of the A.E.C.B. with respect to Codes of Practice and the ALARA principle. It could also - with some minor additions - provide an overview of the objectives and sequence of the course itself. This overview was sorely missing from the Saskatoon course which launched immediately into

the physics of radioactive substances without placing the industry and the course itself in perspective.

6.3 Regulatory Philosophy for Uranium Mining (Lecture 15)

This lecture should terminate the formal course lectures. The themes which it introduces - cooperation between the regulatory agency and mine management which leds to the ALARA principle in mine operations; and the internal responsibility system which challenges management, worker representatives, and workers themselves are a fitting conclusion to the formal lecture sessions.

7. Lab Sessions

We find that the time devoted to practical lab sessions is neither realistic nor consistent with the overall aims of a basic course in radiation safety.

Stope and drift miners for instance, have different monitoring, prevention and control responsibilities than do mill workers, ventilation engineers and technicians, radiation samplers, etc. The logistics of addressing these variables is further complicated by the variety of methods and equipment used within the operational environment. Simulating this environment is impossible. Moving training into this environment in order to teach and validate the achievement of this objective under realistic conditions and constraints would be to usurp the licencee's responsibilities as documented in Part II of the proposed training philosophy.

We do not recommend the deletion of these sessions because they afford an excellent opportunity to review and consolidate unit measurements and terms; the principles of ventilation; personal and traditional dosimetry monitoring techniques; and record keeping practice. To accomplish this they must be shortened, resequenced, and placed within the context of valid case studies. For instance, a half-day session in the dust lab could be build

around the scenario of dust survey techniques in the underground and or mill environments. A half-day session on radiation sampling could be placed within the context of dose and exposure monitoring for a working shift.

## C. INSTRUCTIONAL QUALITY

### 1. Presentation Style

The lecture is a telling method of instruction. It is the process of transferring information about something to somebody. This method is especially useful for giving new facts or information to a group and is a valid method of instruction for communicating a large portion of the content in the U.M.R.S.C. Information, of course, must not only be delivered; it must also be received and retained for future use if course participants are to lead by example in the workplace. Chapter A has foreshadowed our major concerns in this regard:

- the failure to present abstract concepts in terms and examples
  which the base entering behaviour can relate to;
- the failure to provide visual relief for teaching points.
  (see also Appendix B, B1;B2)

With the exception of the Mildon (Biological Effects of Dust) and the Dory (Regulatory Philosophy for Uranium Mining) lecture, all other lectures, to a greater or lesser degree, violate the principles for effective visual aids. A number of lecturers, however, rise above this difficulty and the present success of the U.M.R.S.C. can be directly attributed to the lecturing skills evidenced by J. Viljoen (Radiation Exposure Record Keeping in Mines and Mills); W. Napier (The Regulatory Process); V. Elaguppillai (Regulatory Basis of Dose Limits and Radon and Thoron Daughter Exposure Limits); W. Jones (Worker Education); W.A. Bardswich (Sources and Control of Dust in Mining and Milling); and C.A. Mildon (Biological Effects of Dust). These lecturers exhibit

subject-matter expertise in combination with the organizational and platform skills which effective lecturing demands. The Viljoen lecture serves as a demonstrative example for this group of lectures.

1.1 Radiation Exposure Record Keeping in Mines and Mills - J. Viljoen

This lecturer - seventh in sequence for the Saskatoon course - was the first to give an outline and purpose for his lecture; the first to place his lecture within the framework of previous and succeeding material; the first to welcome and actively encourage questions; the first to summarize and reinforce as he proceeded; and the first to provide a detailed summary of the outline and purpose of his lecture. These organizational and technical skills were further enhanced by an active, enthusiastic presentation.

The organizational and technical skills noted above should be an integral part of every lecture session. Personal presence skills of poise, eye contact, voice, mannerisms, movement and enthusiasm are more difficult to instill but can be nurtured through counselling or formal training in instructional techniques.

2. Visual Aids

At present the majority of lectures are one-dimensional in terms of learning aids. Overhead follows overhead to the point of redundancy. Many of these overheads are so cluttered with verbal or numerical information that they cannot even be read - let alone absorbed - by course participants before they are removed by the instructor.

If an aid is to be effective it must display two essential attributes.

(1) Unity: the aid should have only one basic idea or central theme; and a series of aids should lead cumulatively to the achievement of an objective.

(2) Simplicity: There should be nothing used that is unnecessary or irrelevant to that central theme. Any embellishment can be done orally. (see also Appendix B, B1; B4)

This, of course, is the advantage in drawing visual aids from the working environment itself. Not only are they likely to be more meaningful to course participants and stimulate a variety of relevant questions but they also give rein to the instructor to embellish these aids with personal expertise and experience.

## D. COURSE ADMINISTRATION

### 1. Administrative Effectiveness

Competent course administration is a function of careful planning and skillful implementation. The Procedures Manual for Uranium Mine Radiation Safety Course (see Appendix C) prepared by the Canadian Institute for Radiation Safety (CAIRS) adequately attests to the deliberate, precise planning which precedes, accompanies and follows the U.M.R.S.C. Couple this planning with the conscientious implementation evidenced by the Course Chairman and support staff from the Saskatchewan Mining Development Corporation and the result is a smoothly run congenial course, administered in a competent professional manner.

### 2. Course Facilities

Course facilities were perfectly adequate and met the demands of both classroom and laboratory instructors.

3. Social Activities

These were well run, and with the exception of the welcoming reception which was poorly attended, provided an excellent forum for informal discussions between participants and instructors. The Wednesday evening film and discussion session was particularly effective in this regard.

4. Panel Discussion

Competently chaired by the Executive Director of the Canadian Institute for Radiation Safety, this tri-partite panel discussion provides an excellent ending to the course. It effectively reviews the roles and responsibilities of the regulatory agency, management, worker repesentatives and workers in working cooperatively towards the ALARA principle of radiation safety in mining workplaces. Future courses should allow three hours for this discussion as questions were still on the floor when the panel discussion was terminated.

E. CONCLUSION

There is much to commend in the present U.M.R.S.C. Professional administration by the Canadian Institute for Radiation Safety coupled with the clearly projected concern of course lecturers with the health and safety of workers in the uruanium mining environment result in a valuable forum in uranium mine safety training.

These factors auger well for future offerings of this course. With the critical logisitical support already in place revisions respecting sequence and the standardization of presentation styles can be smoothly implemented. These revisions, supplemented by the increased use of visual aids drawn from the operating environment will provide a practical framework for course participants to emulate in their day-to-day workplaces.

APPENDIX A

COURSE EVALUATION

A) For each of the statements below, circle the number that comes closest to expressing your opinion. (Note that the words written under numbers 1 and 7 on the scale are not the same for each question.

1. Was the course content what you expected it to be?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Exactly |

2. Did you receive accurate information about the course before comining?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| not at all | | | | | | Exactly |

3. What do you think of the length of time taken for this course?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Too short | | | Just right | | | Too long |

4. What was the quality of the training facilities?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Inconvenient | | | | | | Convenient |

5. Did the instructional methods keep you interested?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Extremely |

6. What was the quality of the handouts you received?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Poor | | | | | | Excellent |

7. How suitable was the amount of lecturing?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not enough | | | Just right | | | Too much |

8. How suitable was the amount of discussion?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not enough | | | Just right | | | Too much |

9. How was the speed of presentation?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Too slow | | | Just right | | | Too fast |

10. Did you have enough practise with new skills?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Definitely |

11. Course leader's organization and preparation was:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Poor | | | | | | Excellent |

12. Course leader's mastery of subject was:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Poor | | | | | | Excellent |

13. Overall quality of instruction was?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Poor | | | | | | Excellent |

14. Were you satisfied with the results you achieved on this course?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Extremely |

15. Was the course content relevant to your job?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Completely |

16. How thoroughly were the subjects covered?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Completely |

17. Can you apply the material that was presented?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Completely |

18. Do you think you can now do your job better because of this course?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Definitely |

19. Would you recommend this course to your colleagues?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | | | | | | Highly |

20. What was the overall value of this course to you?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| No value | | | | | | Extremely valuable |

B. Comments and Suggestions

1. Which information was of most value to you?

_____

_____

2. Which information was of least value to you?

_____

_____

3. What suggestions would you make to improve the course?

_____

_____

4. Additional comments.

_____

_____

_____

_____

APPENDIX B

## AUDIENCE ANALYSIS KNOWLEDGE

High

- use language of the trade but explain any acronym or terminology the first time it's used
- give a big picture overview
- say only things that are useful to them. Avoid detail already known.

Medium

- omit complex discussion or subject area not vital to the purpose
- fill in their knowledge gap to the level you require
- be careful of jargon
- use frames of reference they know
- watch for signs of lack of comprehension

Low

- limit the number of points, look for signs of saturation
- lay groundwork, but without being overbearing
- avoid jargon, and special terminology
- lean heavily toward illustration
- use what they are familiar with; use analogies; move from general to specific
- use visuals that lean toward pictorials and simplicity
- repeat key points or restate them in different terms
- summarize sections
- allow sink in time, and encourage questions.

## BUILDING CONTENT - VERBAL CHECKLIST

| Have you: | YES | NO |
|---|---|---|
| 1. Ensured the material is relevant to the topic and appropriate in taste? | | |
| 2. Used several types of support to account for differing audience backgrounds? | | |
| 3. Provided enough support to prove your case? | | |
| 4. Checked your facts? | | |
| 5. Used examples of your own experience? | | |
| 6. Cited three examples for each point? | | |
| 7. Used analogies? | | |
| 8. Rounded off statistics? | | |
| 9. Used sources the audience will respect? | | |
| 10. Check on the pronunciation of names? | | |

## BUILDING CONTENT - VISUAL CHECKLIST

| | | YES | NO |
|---|---|---|---|
| 1. | Does the AV medium or media suit the audience purpose, situation and environment? | | |
| 2. | Can each visual be read without strain from all parts of the room? | | |
| 3. | Does each visual convey only one main idea? | | |
| 4. | Does the aid help the audience understand by simplifying, highlighting, comparing and visualizing? | | |
| 5. | Does the title state the essence of the visual? | | |
| 6. | Is the material presented in bite-size pieces to keep audience attention focussed? | | |
| 7. | Is complex material sequential? | | |
| 8. | Is all material on the visual discussed? | | |
| 9. | Are unneeded details, words or numbers removed? | | |
| 10. | Is each aid no more than seven items, lines or blocks? | | |
| 11. | Is all lettering horizontal? | | |
| 12. | Have you personally proof read all visuals to ensure correct spelling? | | |

# PRESENTATION STRUCTURE

## INTRODUCTION

- catch attention
- establish rapport
- provide motivation
- state purpose of the message
- provide direction

## BODY

- give main theme or thesis statement
- give first main point
    - substantiating data
- give second point
    - substantiating data
- give third main point (and so on)
    (stick to one pattern of organization)

## SUMMARY

- restate main points and message
- make conclusions/recommendations
- ask for action
- wrap up

## EVALUATING INSTRUCTIONAL OBJECTIVES

| | | YES | NO |
|---|---|---|---|
| 1. | Are they based on Task Analysis? | | |
| 2. | Do they use action verbs? | | |
| 3. | Do they list a performance? | | |
| 4. | Do they include conditions? | | |
| 5. | Do they include standards and outputs? | | |
| 6. | Are they measurable? | | |
| 7. | Do they focus on the learner? | | |
| 8. | Are they specific? | | |
| 9. | Are they clear and understandable? | | |
| 10. | Do they avoid jargon and unfamiliar words? | | |
| 11. | Are sub-objectives listed for each objective? | | |
| 12. | Will the objectives be interpreted the same way by various people? | | |
| 13. | Do they avoid vague and imprecise words? | | |
| 14. | Are they concise? | | |
| 15. | Are they attainable? | | |
| 16. | Are they appropriate for the population? | | |
| 17. | Are they grammatically correct? | | |
| 18. | Are they realistic and job-like? | | |
| 19. | Do they include stimulus events? | | |
| 20. | Do they include terminating events? | | |
| 21. | Do they include tools, equipment and materials? | | |
| 22. | Do they include real world circumstances? | | |

## EVALUATING INSTRUCTIONAL SEQUENCING

| | | YES | NO |
|---|---|---|---|
| 1. | Does instruction move from: | | |
| | a) Simple to complex? | | |
| | b) Known to unknown? | | |
| | c) Concrete to abstract? | | |
| | d) Whole to parts and back to whole? | | |
| | e) Observations to reasoning? | | |
| 2. | Does instruction contain prerequisite sequence? | | |
| 3. | Does instruction contain job sequence? | | |
| 4. | Are easily learned tasks covered early in sequence? | | |
| 5. | Are general and broad concepts covered early in sequence? | | |
| 6. | Are similar tasks grouped together? | | |
| 7. | Does the sequence alternate from the difficult to the less difficult? | | |
| 8. | Are "shared" concepts learned early in the session? | | |
| 9. | Do motivating/enjoyable items come early in session? | | |
| 10. | Are "heavy" sessions avoided during the latter part of the a.m. and p.m.? | | |
| 11. | Are the high points of the day, 9:00 - 11:00 and 1:30 - 3:00 used adequately? | | |
| 12. | Is there a good lead up to the conclusion? | | |

# EVALUATING INSTRUCTIONAL STRATEGIES

| | YES | NO |
|---|---|---|
| **A. Motivation** | | |
| 1. Is there a change in method, media or activity at 20 minute intervals or less? | | |
| 2. Is the level of challenge appropriate? | | |
| 3. Does the content fit the learner's viewpoint? | | |
| 4. Does the session meet learner's needs? | | |
| 5. Are objectives clearly stated to the learner? | | |
| 6. Are objectives stated early in the session? | | |
| 7. Are the objectives related to job requirements? | | |
| 8. Are session plans and scheduled activities explained to the learner? | | |
| 9. Is there variety in methods and media? | | |
| 10. Is Nice to Know data used to spark interest? | | |
| 11. Is excessive Nice to Know data avoided? | | |
| 12. Is the pace varied? | | |
| 13. Is the importance of the content pointed out? | | |
| 14. Is the relationship between content and job conditions pointed out? | | |
| 15. Is the learner constantly responding to and applying the content? | | |
| 16. Are learners made aware of their progress? | | |
| 17. Is the session designed to make learning successful in most responses? | | |
| 18. Do learners have a chance to express themselves? | | |
| 19. Is material introduced in an appealing way? | | |
| 20. Is group competition used? | | |
| 21. Are co-operative efforts planned? | | |
| 22. Are strategies employed to produce group interaction? | | |
| 23. Are small group exercises planned? | | |
| 24. Do small groups consist of 3-6 people? | | |

| | YES | NO |
|---|---|---|
| **B. Acquisition** | | |
| 1. Is there an overview of the session? | | |
| 2. Are similarities and differences with previous learning pointed out to the learner? | | |
| 3. Are frequent reviews and summaries done? | | |
| 4. Are the reviews and summaries done by the learners? | | |
| 5. Is technical jargon omitted where possible? | | |
| 6. Are common terms used in explaining? | | |
| 7. Are many senses employed by the learner? | | |
| 8. Is practice distributed appropriately over the session? | | |
| 9. Is enough content covered in the time available? | | |
| 10. Is overloading of the learners avoided? | | |
| 11. Is the sequence appropriate (See Evaluating Instructional Sequencing handout)? | | |
| 12. Are there frequent pauses in the action to allow for mental review? | | |
| 13. Is there a final summary? | | |
| 14. Is approximately 60-70% of the session devoted to Application and Feedback? | | |
| 15. Is explanation limited to approximately 30% of the session? | | |
| 16. Is feedback provided to learners about their performance? | | |
| 17. Is the feedback specific? | | |
| 18. Is the feedback immediate? | | |
| 19. Is the feedback complete? | | |
| 20. Is opportunity given for active recitation by the learner? | | |
| 21. Are key items repeated during the session? | | |
| 22. Are key items covered in the beginning and/or end of the session? | | |

| | | YES | NO |
|---|---|---|---|
| 23. | Is overlearning done for memory-type items? | | |
| 24. | Are examples based on familiar situations and objects? | | |
| 25. | Are plenty of examples, cases, samples, etc. used to provide impact? | | |
| 26. | Are numerous questions used to promote thought? | | |
| 27. | Is the session job-like? | | |
| 28. | Do learners actually perform the task(s)? | | |
| 29. | Are complex items repeated in different words? | | |
| 30. | Are component parts practiced before total tasks are attempted? | | |
| 31. | Is a "model" of good performance presented to the learner before he is asked to respond? | | |
| 32. | Is there enough practice under varied conditions to assure transfer to the job situation? | | |
| 33. | Do early practice sessions contain more prompting than later sessions? | | |
| 34. | Do early practice sessions contain fewer complexities and variables than later sessions? | | |

## EVALUATING INSTRUCTOR LESSON PLANS

| | | YES | NO |
|---|---|---|---|
| 1. | Does it contain clearly stated objectives? | | |
| 2. | Does it specify facilities, such as type, size, arrangement and location required for the lesson? | | |
| 3. | Does it state the length of time required? | | |
| 4. | Is the type of instruction indicated, ie., lecture, demonstration, lab experiment, hands on, etc.? | | |
| 5. | If highly specialized skills or knowledge are required of instructors, does it describe them? | | |
| 6. | Does it list all references needed by trainees and instructors? | | |
| 7. | Does it state what aids will be used, ie., overheads, film, flipchart, fixed charts, slides, etc.? | | |
| 8. | Does it list by title and number all types of handouts to be given to the trainee? | | |
| 9. | Does it list supplies the trainee needs to bring to class; for example, pen, pencil, notebook, etc.? | | |
| 10. | Does it contain a good introduction to the lesson? | | |
| 11. | Does it contain a logical sequence? | | |
| 12. | Is the lesson divided into small units? | | |
| 13. | Is enough time spent on each unit? | | |
| 14. | Is the lesson easy to follow? | | |
| 15. | If questions are included are they properly worded? | | |
| 16. | Is there a chance for application by the student; if only in his mind? | | |

EVALUATING INSTRUCTOR LESSON PLANS



| | YES | NO |
|---|---|---|
| 17. Does it contain variety? | | |
| 18. Does it describe the means used to check trainee performance on the task? | | |
| 19. Does it contain adequate summaries and reviews? | | |
| 20. Does it contain a reasonable, logical follow-up assignment? | | |

APPENDIX C

# PROCEDURES MANUAL FOR URANIUM MINE RADIATION SAFETY COURSE

## A. INITIAL PLANNING MEETING, OTTAWA

The Executive Director, Scientific Director and Ottawa Liaison Officer attend this meeting on behalf of CAIRS. The meeting is usually held 6 - 8 weeks after the previous course. The critique for the previous course is discussed and any amendments as well as the date for the next course are made at this time.

## B. BUDGET/CONTRACT

The detailed budget for two courses is submitted to AECB in December after the second course of the current year is complete. This budget is also discussed at the Ottawa planning meeting. Any deletions, or additions are made at CAIRS and returned to AECB for approval.

A contract is issued by DSS.

A progress for payment claim showing a 15% holdback is made after each course. Claim one shows the expenses incurred for the current course. Claim two is the request for the 15% holdback for the same course. To date, CAIRS has not sent support data for claims although it is kept available at Elliot Lake. There has been little concern expressed about overspending in any one area provided that the total budget for the course has not been exceeded. Courses are now known as UMRSC 1/83 and UMRSC 2/83 etc.

C. BROCHURE

The brochure is prepared and mailed about 3 months in advance. The distribution list is located in the filing system (231.145). New participants receive announcements for 2 or 3 future courses. Some are placed on the permanent distribution list.

PARTICIPANTS

The application forms (part of brochure) are dealt with in the following manner:

1. Received and date stamped by secretary.
2. Fee and application are forwarded to the bookkeeper.
3. Receipt for fee and application are returned to Secretary who sends letter of acknowledgement and pre-course questionnaire to applicant.
4. Letter of acceptance and joining instructions are forwarded to participant after closing date.
5. Fee is non-refundable after acceptance.
6. Nominal list is prepared after closing date. Participants are categorized i.e. mine inspectors; government; industry; union and others
7. Nominal list is part of "Course Notes".

A block of rooms is set aside at a local hotel and it is suggested to participants that accommodation reservations be made there.

Participants are responsible for travel and hotel reservations although the hotel registry is compared to list of "out of town" participants.

Participants to the Elliot Lake Course are met at the airport by CAIRS Personnel and taken to hotel. In Saskatoon, participants find their own way to the hotel.

A Shuttle bus service is operated to and from the hotel and classroom several times each day. Participants are expected to be on time for the bus since the timetable is strictly adhered to.

LECTURERS

The AECB is responsible for:

1. Lecture topics
2. Lecture outline
3. Proposed lecturer names
4. Initial request for service of new lecturers
5. Timetable.

The CAIRS is responsible for:

1. Contacting former lecturers by telephone to confirm timetable
2. Contract letter to all lecturers
3. Alphabetical nominal list
4. Travel and accommodation, if requested
5. Joining instructions
6. Pick up at airport
7. Nominal list is part of "course notes"
8. Biography

F. PANEL

Panel members are proposed and the initial invitation issued by AECB.

Follow up letter including times, places, etc. is prepared by CAIRS.

There are usually 7-8 members representing industry, Provincial and Federal Government. (AECB, Labour, Canada) and Labour Unions. The Chairman is from CAIRS.

G. FIELD VISITS

Since Field visits in Saskatchewan are very costly, none are made.

Field visits in Elliot Lake are made as follows:

1. AECB makes formal request to officials of mining companies

2. Underground familiarization tours are arranged by CAIRS

3. Mill tours are usually voluntary

4. Underground sampling is done as part of 2nd week practical sessions and is arranged by CAIRS.

## H. COURSE NOTES

1) Lecture Notes

a) Lecturers are asked to submit their notes to CAIRS one month before the commencement of the course.

b) A lecture format has been determined.

c) A lecture number is assigned (LT )

d) Forty copies of each lecture are made at CAIRS (double sided, metric paper).

2) Contents

a)
b)
c)
d)
e)
f)

3) Binding

a) CAIRS metric size cover
b) Cerlox binding
c) Bound at Woodland Printers, Cutler

4) Distribution

a) To each participant, first day of course
b) To lecturers who request copy.

I. SOCIAL ACTIVITIES

a) Welcome Reception Elliot Lake and Saskatoon
Sunday evening before course begins.
Buffet lunch, held in hotel where participants are accommodated. This reception is to introduce participants to each other and meet staff at CAIRS and lecturers. Some local industry and labour officials invited.

b) Farewell Banquet, Elliot Lake
Thursday evening of course week held in the Kindiogami room at CAIRS.
Sit down served meal.
Local officials of union and industry are invited as well as instructors staying over.

c) Farewell Banquet Saskatoon
Thursday evening of course week held in hotel accommodating the participants.

J. EQUIPMENT

CAIRS is building an inventory of equipment and films for use in the practical sessions by CAIRS. Other training aids are being considered.

K. CERTIFICATES

The certificate designed by AECB is issued to any participant who completes the course.

## L. MISCELLANEOUS

Purchase orders are issued for:

a) rental of van or car;
b) reception and banquet;
c) any equipment purchased;
d) binding of course notes;
e) certificates.